# SUGAR BEETS.

PRESS BULLETIN NO. X 8

## UNIVERSITY EXPERIMENT STATION.

ST. ANTHONY PARK, MINNESOTA, APRIL 13, 1897.

The United States Department of Agricuiture has arranged to send out to the several states a limited quantity of sugar beet seed, donated by Mr. Oxnard of Norfolk, Neb., with instructions how to plant, cultivate, and how to send samples for analysis. Dr. A. C. True, Director of the Office of Experiment Stations of the United States Department of Agriculture, writes that Minnesota was not included in the list because the Minnesota Experiment Station had already done extensive experimenting along this line. We are in daily receipt of many letters inquiring regarding our experiments, the richness of sugar beets grown in Minnesota and their general average coefficient of purity; also the cultivation and probable profits.

I herewith submit a Press Bulletin prepared by Harry Snyder, Agricultural Chemist, and Willet M. Hays, Agriculturist, giving the information desired, the bulletins previously published being exhausted.

WM. M. LIGGETT,
Director.

## SUGAR BEETS.

*Previous Work of the Experiment Station.*—From one to five acres of beets have been grown on the Experiment

Station Farm every year since the establishment of the station in 1888. In addition to the beets which have been grown at the station, seeds have been distributed nearly every year to farmers in various parts of the state. The beets grown on the Station Farm as well as those raised by farmers and sent to the station, have been analyzed every year during the past eight years. Bulletin No. 14 issued in January, 1891, contains the results of the analyses of 55 samples of sugar beets, grown in twenty counties. Bulletin No. 21 contains the analyses of 465 samples of sugar beets grown in 49 counties. This bulletin also gives the details of experiments conducted at the Experiment Station Farm relating to the cost of production, method of cultivation, and test of varieties. Bulletin No. 27 contains the analyses of 185 samples of beets grown in 30 counties. These bulletins give the county in which the beets were grown, the post office address and name of the grower, the date of seeding, date of analyses, size of the beet, per cent of sugar, and purity coefficient. The U. S. Department of Agriculture has also published the analyses of 187 samples of beets grown in Minnesota. Since the publication of the last sugar beet bulletin 187 samples of beets have been analyzed by this station.

During the eight years the experiments have been in progress 1079 samples of sugar beets grown in Minnesota have been analyzed, yielding an average of 14.04 per cent sugar, and a purity coefficient of 80.54.

The following table has been prepared giving the average per cent of sugar for each year, the highest per cent of sugar, the lowest per cent of sugar; the average, the highest, and the lowest coefficient of purity; the number of samples of beets analyzed, and also the number of counties in which the beets were grown.

| | 1888 | 1890 | 1891 | 1892 | 1893 | 1894 | 1895 | 1896 |
|---|---|---|---|---|---|---|---|---|
| **Average per cent sugar** | 15.4 | 12.92 | 14.1 | 15.0 | 15.2 | 17.2 | 15.6 | 13.7 |
| Highest " " | 20.3 | 17.87 | 20.4 | 19.1 | 18.4 | 19.4 | 20.6 | 18.2 |
| Lowest " " | 6.5 | 7.77 | 6.5 | 11.1 | 10.2 | 12. | 11.8 | 12.8 |
| **Average coefficient of purity** | 83.1 | 79.45 | 80.1 | 84.6 | 84.4 | 86.6 | 85.6 | 80.9 |
| Highest " " | 87. | 87.9 | 96.6 | 93.9 | 87.8 | 89.8 | 94.2 | 88.2 |
| Lowest " " | 67. | 63.1 | 60.8 | 76.1 | 78.4 | 78. | 76. | 78. |
| Number of separate samples analyzed | 111 | 55 | 465 | 185 | 15 | 14 | 22 | 25 |
| Number of counties represented | 10 | 20 | 49 | 30 | 5 | 3 | 6 | 4 |

General average per cent sugar 8 years, 1079 samples, 14.04.
General average coefficien of purity, 80.54.

The above results were all obtained by the use of a Schmidt and Hensch polariscope. The experiment station laboratory is especially well equipped for sugar beet work. The beets were ground by power furnished by a gasoline engine. The pulp was pressed in a large press made especially for the work. All of the brix spindles, flasks and apparatus were carefully tested and everything that could be done was done to secure the greatest accuracy in the work.

*Explanation of terms.*—The per cent of sugar represents the per cent of sugar in the beet juice. If a beet is ground to a fine pulp and then submitted to heavy pressure, about 95 per cent of the materials in the beet are pressed out with the juice. If the juice contains 15 parts of solid matter in 100 parts of the juice and 12 of these 15 parts are sugar, then $^{12}/_{15}$ or 80 per cent of the solids of the juice are sugar, or the coefficient of purity is said to be 80. If the juice contains 16 parts of solids instead of 15, then the purity coefficient is 75.

For sugar making purposes the juice should contain 12 per cent sugar, and the purity coefficient should be, at least, 80. If the beets contain more than 12 per cent sugar, or if the coefficient of purity is above 80, then they are more valuable for sugar making purposes.

It is to be observed that the sugar beets grown in Minnesota are above these standards required for sugar making purposes.

*Results Obtained When Experiment Station Beets were sent to Sugar Beet Factories in Nebraska.* In addition to the analyses of beets, the Experiment Station has sent beets

to the sugar factories in Nebraska. In the fall of 1892, a car load of sugar beets grown on the Experiment Station farm at St. Anthony Park, was sent to the sugar beet factory at Grand Island, Neb. President Oxnard, of the Oxnard Sugar Beet Factory, wrote as follows:

February 24th, 1893.

Director of the Experiment Station,
St. Anthony Park, Minn.

DEAR SIR: "In reply to your favor I will say that your beets were most excellent in every respect, both as to size and quality. If this kind of beets can be grown on a large scale there is no doubt whatever of the adaptability of the soil in your neighborhood to the growth and development of sugar beets. The test showed 14.9 per cent of sugar with a high purity co-efficient." Very truly yours,

HENRY T. OXNARD.

The year that these beets were sent to the factory (1892) 73 samples of beets raised at the station tested 147, per cent sugar. These results are given in bulletin No. 2.9 which was published about a month before the receipt of this letter. It is to be observed that the factory tests and the laboratory tests are identical. The beets were paid for on the basis of 14.9 per cent sugar.

Beets from other parts of this state have also been sent to sugar beet factories. In 1892, Mr. Max Wittges, a German sugar beet expert, spent the season in Anoka county and vicinity, conducting experiments. He personally supervised the cultivation of the beets on about 20 farms. Two car loads of beets were sent to the sugar factory in Nebraska. Mr. Wittges reported the conditions for sugar beet culture as very favorable. Some of the beets grown under his supervision and sent in to the station contained as high as 18 per cent sugar, and a purity coefficient of 90.

*Essential Conditions for Sugar Beet Culture.* The three most essential conditions for the production of sugar beets are: (1) climate, (2) rainfall, (3) soil.

*Climate.* A study of the climate of the best sugar beet sections in Europe shows that the best conditions exist when

the mean summer temperature for the three growing months of June, July, and August, is about 70° F. A map, prepared by the United States Department of Agriculture, from the Weather Bureau records for 10 years, shows that a large part of Minnesota has this ideal temperature. The isotherm of 70° F enters the state a little south of St. Paul, curves north and leaves the state at about the 44 parallel. A zone of 100 miles on either side of this line of 70° temperature for the three growing months is considered to be the ideal temperature for sugar beet raising. There are many localities in Minnesota that have just the right temperature conditions for this crop.

(2) *Rainfall.*—The amount of rainfall necessary to mature a crop of sugar beets depends upon the nature of the soil, and the dryness of the atmosphere. Two inches of rain per month during the three growing months of June, July and August, with good cultivation, will insure a crop of sugar beets. If the soil is well stocked with moisture in the spring, and the proper cultivation is given, so as to conserve the soil moisture, less water, in the form of rain, will be required. For sugar beet culture there should be an annual rainfall of at least 25 inches. A dry spring and summer, followed by a rainy September, produces a poor quality of beets for sugar making purposes. A dry fall, up to Oct. 10, is favorable for the proper maturing of the crop. A dry summer, followed by a wet fall will cause the beets to begin a second growth, which decreases the content of sugar. There are many localities in this state where the necessary conditions as to rainfall exist.

(3) *Soil.*—The sugar beet thrives best on a loam soil; one that contains a fair amount of sand. The subsoil should be of a claylike nature so as to be sufficiently retentive of water. A good corn soil is usually a good beet soil. On alkali soils the beets are of poorer quality, because the alkaline salts are taken up by the beets in abnormal amounts, which reduces the purity of the juice. Beets should not be grown on sour muck soils. The soil should be in a good state of

fertility. Manure, as raw stable manure, cannot be applied directly to the crop, because it makes the beets too large and pulpy. The manure must be applied to the preceding crop, as corn. *The soils of this state, at present, do not require any manuring for raising sugar beets. A little later manure will be required.* A soil that has been under cultivation, to grain crops, is in better condition for sugar beets than new prairie soil.

For beet growing purposes this state has as good soils as could be desired.

*The Quality of Minnesota Sugar Beets.*—Reviewing all of these facts: Climate, rainfall, soil, the 1000 and more samples analyzed by the Minnesota Experiment Station, covering a period of eight years, the actual test of sending the sugar beets to the sugar factory, and the endorsement as to their quality by President Oxnard, we are led to believe that the Minnesota Experiment Station has demonstrated that sugar beets, with proper cultivation, can be grown in this state, containing a very high per cent of sugar and purity of juice. Additional experiments along this line hardly seem necessary.

*Two Phases of the Sugar Beet Problem.*—It is no longer a question can we raise good sugar beets? it is now a question will it pay to make sugar? This is a commercial problem that must be answered by the farmer and the sugar manufacturer. It is to be hoped that if sugar beet factories are to be established that the problem will be carefully studied, so that there will be no failures. It has been the aim of the station to determine, in as thorough and impartial a way as possible the adaptability of Minnesota's soil and climate to the culture of sugar beets, and it is believed it has solved this phase of the problem.

*Special Peculiarities of the Sugar Beet Crop.* The sugar beet is a very sensitive plant. If not given the proper cultivation at the right time, it will produce a poor yield of sugar. The amount of sugar present has been found to be

directly proportional to the care given to it's crop. It should be the aim to produce small beets rather than large ones. A beet weighing 1 or 2 pounds is better for sugar making purposes than one weighing 3, 4, or 5 pounds. When the beets are grown 3 or 4 inches apart, in the row, they will not grow so large as when planted farther apart. In the table of analyses the lowest per cent of sugar is given as 6.5, this is on account of large, unripe beets, being sent on for analyses. It is a common belief that beets weighing 3 or 4 pounds contain more sugar than smaller beets. A great many have insisted upon picking out and sending to the station the very largest beets. These beets contain the smallest amount of sugar. This has made our results a little lower than the true average should be, but nothwithstanding this fact the average is very high. A great many persons seem to think that a beet is a beet, but there is as much difference between beets as there is between good and poor cows.

Beets that have been grown on hard clay land which has not been properly plowed generally have parted roots, and grow above the ground. Such beets are very poor for sugar making purposes. When grown for the sugar factory, the beets must be more carefully grown than when intended for feeding stock.

*Yield per Acre.*—There is a general tendency to overestimate the yield per acre of beets. While it it possible to obtain as high as 30 or 40 tons of beets per acre, the average yield is more nearly 14 tons per acre.

*Feeding Value of Beet Pulp.*—The pulp, or sugar beet chips as they are sometimes called, is valuable for feeding purposes. It contains about 11.6 per cent water, 6.6 per cent protein, .6 per cent fat, 19.3 per cent fiber, 54.8 per cent of carbohydrates. It is not a complete food, but like the refuse from starch factories, it is a valuable adjunct in a ration, imparting palatability and digestibility. Its food value has by many been over estimated. In European countries, where cattle foods are more expensive, every fodder article has a definite value; in this country, where there is such an

abundance of cheap cattle foods, as in this state, the pulp residue would not be such an important animal food. It could not compete with bran and shorts at $4 to $6 per ton, nor with our cheap corn fodder or hay. The pulp is nevertheless a valuable food, the same as potatoes where properly used.

*Co-operation Between Farmers and Sugar Factories.*—Wherever a sugar beet factory is established, the most cordial relationship between the farmer and the manufacturer is absolutely necessary. Many factories have been compelled to close because they could not obtain beets in sufficient quantities. The following letter illustrates this point:

NORFOLK, Neb., Nov. 12, 1892.

Director Experiment Station,
St. Anthony Park, Minn.

Dear Sir: Yours of the 10th inst, with inclosed bill of lading, duly received, and we have forwarded beets, which arrived today, to Grand Island, as this factory had shut down and could not keep open any longer for want of material, but the Grand Island factory is working, and will acknowledge the beets from that point.

Yours very truly,
J. G. HAMILTON, Secretary.

A sugar beet factory is a very expensive plant, and capital cannot be induced to come into this industry unless a sufficient supply of beets can first be guaranteed.

*Date of Planting, Time of Maturing.*—The best time for planting sugar beets in this state has been from May 5 to June 1, depending, of course, upon the season. Beets sown as late as June 10th and even June 15th have matured before the early fall frosts. If the beets are sown too early, the plants that are produced are not as vigorous as when planted later, and the very early plantings are usually poorer in sugar. This is doubtless due to the vitality of the plant having been partially exhausted in its early struggles. We have about a month's range for beet seeding. Beets mature in about 110 or 120 days after seeding, depending upon the variety of seed, and the season of the year. During the

past eight years that our experiments have been in progress the crop has always matured before the early fall frosts. When the beets have reached their full maturity, the outer circle of leaves turns yellow, while the inner circle still retains a green tinge. If the beets are not harvested at the proper time, and begin to make a second growth, the amount of sugar is decreased. Freezing and then thawing also reduces the per cent of sugar. Full maturity of the sugar beet, at the experiment station, has usually been from Sept. 20 to Oct. 1, depending upon the season and time of seeding.

*Analysis of Beets.*—Many inquiries have been received regarding the testing of beets by the station. The experiment Station, St. Anthony, Minn., will analyze samples of beets that are sent in, provided the express charges are prepaid. The analysis will be made free of cost if the beets are sampled and sent according to directions, which will be furnished by this station.

HARRY SNYDER,
Chemist.

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## THE CULTIVATION OF SUGAR BEETS IN MINNESOTA.

In view of the fact that organizations have been formed at a number of centers in the state with the object of securing sugar beet factories, some plan should be inaugurated for properly growing the beets this year in a practical field way. though on a small scale. It is now late for companies to contract with farmers to raise the beets and to erect factories in which this year's beet crop may be utilized. Companies contemplating the erection of factories should select the towns at which they may hope to start factories this season and arrange to have trial plots grown, or the citizens wishing to secure factories should organize and have a number of farmers grow each a small plot of beets. The best land available should be chosen, the best improved seed should be secured, the preparation of the soil should be most carefully done, the seed should be properly planted, cultivated, thinned and harvested and the yield secured. A

sample should then be sent by the officers of the company or co-operative association of farmers to the Experiment Station to get the per cent of sugar and the purity of the juice, that the possible income per acre may be calculated. A careful record should be made of all operations and an accurate account kept of the cost of the beets per acre that the cost per ton and the possible profits on the crop may be estimated and that the farmers may learn how to grow the beets. Upon application to the station, blanks will be furnished upon which the records of the crop may be entered and the facts compiled. Where the beets are grown in a practical way for yield of sugar per acre, and to learn how to cultivate them, the expense of analyzing them is necessary and wise. The farmer will not lose much in thus raising a plot of one-fifth of an acre of sugar beets, as they can be used at a valuation of two dollars or less per ton for food for live stock. The yield of the crop will be less than of mangels, and the cultivation more expensive because the rows are closer and more hand labor is necessary. The harvesting is more laborious, owing to the beets growing deeper and being smaller and more tedious to pull, top, pick up and handle than mangels. Yet the larger per cent of the solids, owing to their containing eight or ten per cent more of sugar, makes sugar beet for food nearly as economical to grow for stock as are mangels or even rutabagas. By sowing eight or ten pounds of seed per acre in rows thirty inches apart and six inches apart in the row, so as to allow of horse cultivation, sugar beets may be grown fairly cheaply for live stock; but for manufacturing into sugar they must be grown thickly, producing small roots rich in sugar.

*Where and how to Raise the Trial Plots.*—Well drained soil, not too heavy but still retentive of moisture and rich enough for good crops of corn, is best. The trial plot may follow small grain, corn, millet, or almost any crop, though to follow corn all stalks and stubs must be removed. Land clean of weeds can be handled ten dollars cheaper than weedy land, therefore, other crops should be used for cleaning the

land for this crop rather than using this crop for cleaning the land for grain crops. Choose the best, not too rich, cleanest land for beets, since at best this season will now be at a disadvantage because of the lack of special fall preparation.

In raising sugar beets the following rotation on old land would be a good one: corn, manured at the rate of twenty loads per acre the first year, millet the second year and sugar beets the third year. Corn manured ten loads per acre the first year, if indeed manure will be needed, green manure fallow the second year and sugar beets the third might be a still better rotation on many of our cheap lands. We must have clean, deeply plowed land for the beets if we would get larger crops and *have small expense in weeding*. Weeds grow very rapidly in our climate. The preference in time to plow is in the following order: early fall, late fall and spring. When plowing must be done in the spring the land should be plowed one to two inches deeper than it has previously been plowed, better if plowed eight to twelve inches deep unless this means the turning up of too much new soil. Presumably sub-soiling six or eight inches below the bottom of the furrowslice will pay with this peculiar crop. Deeply mellowing the soil encourages the root to develop entirely underground so as to be clean of large side roots and result in the finest quality as to large content of sugar and high purity of juice. Fall plowed land which was not deeply plowed might be again plowed deeper. All spring plowed land should be most thoroughly dragged within a few hours after plowing to prevent baking into clods, as these make the planting and early weeding difficult. The seed bed should be very finely and rather deeply pulverized just prior to planting to kill weeds and to give a good dirt mulch, that the seeds may be planted at a uniform depth, and especially that the surface soil may be delicately handled about the plants in killing the weeds while the plants are yet very young. Getting the field started clean is more than half the battle with the weeds.

The rows in these beet trial plots should everywhere be eighteen inches apart so that all are comparable and as twenty pounds of seed should be sown per acre, the one-fifth of an acre, four by eight rods being a good form, will require

four pounds of seed. If a hand drill is used make marks with a hand garden marker and set the drill to seed the full amount above mentioned. If no drill is at hand make marks with the corner of the hoe or with a marker and scatter the seeds carefully by hand and cover with a hoe. The seeds should be buried at a uniform depth of nearly three-fourths of an inch and the soil should be firmed over them, as with the wheel of the press drill. Plant at medium early corn planting time, or on heavy, wet soil a little later and shallower.

A garden hand wheel hoe is the best implement for the first cultivation. The first may be used before the beets are up, or if rain causes a crust to form, a light harrow may be used before the beets germinate. When the plants are large enough so that the row can be followed the blades on the hand wheel hoe should be run very close to either side of the row. The wheel hoe should be used every week or so, gradually working farther away from the row and a one horse cultivator should be used a few times toward the end of the cultivation. Stir the land in the middle between the rows four or five inches deep, using care not to strike the roots nor go deep close to the row. The cultivation ceases when the leaves meet between the rows. When the plants have four leaves they should be thinned to six or eight inches in the row. This is accomplished by using a four or six inch hand hoe, leaving a bunch of half a dozen plants, or fewer, every six or eight inches in the row. All but the strongest plant and the weeds are then removed from this hill by hand. Hand hoeing to mellow the soil about the plants and to kill weeds in the row should be given once or twice as needed. Where fields rather than trial plots are grown standard seeding and cultivating horse machinery adapted to planting and cultivating several rows at a time should be secured.

For large fields horse beet pullers are used; in small plots the plow should be run close beside the row so that the beets may be pulled over into the furrow. They should be thrown together, topped by means of corn knives, cutting them off at the base of the lowest leaves. They should then be piled in ricks four feet wide and three feet high, placed in the middle of the plot, which may be four by eight rods, one-fifth of

an acre in size, and several inches of earth thrown upon them, leaving an opening every few feet along the top of the ridge, or "silo" a foot in diameter for ventilation. At least a few farmers cooperating at each town should leave the beets in the silo until December to test keeping a portion of the roots into the early winter for giving the factory a long making season. When the weather becomes cold enough to freeze the soil the first six inches of earth should be covered with straw two inches thick when pressed, and this should be covered with a few inches more of soil to hold the straw in place and the ventilation holes should then be closed. When desirable to keep until very late, manure should be spread thickly over the silo to prevent freezing.

Under good conditions growing thickly as above mentioned an average of fourteen tons of beets can be raised on the best beet soils in southern Minnesota and probably our farmers would average nearly twelve tons, ten being the average at the Nebraska factories. While with especially favorable conditions much larger yields can be secured in favorable years; wet spring seasons, or very severe drouths, insect pests and other causes may sometimes result in very small yields or the necessary abandonment of the crop.

With a little education and experience the farmers around towns desiring a sugar beet factory could easily raise sugar beets at four dollars per ton and make money out of the crop if they were able to sell them without too much expense in siloing and handling them in cold weather. The early advent of winter would require that the factory must contract to take in all beets not later than the latter part of November, else large loss might be entailed from frozen beets.

WILLET M. HAYS, Agriculturist.